Education

Instructional Objectives for Clinical Practice: Nuclear Medicine Technology

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Teaching by objectives is an instructional method that has proven to be most effective and efficient for the type of material that must be transmitted to the student of nuclear medicine technology; it is the instructional method designed for evaluation by criterion-referenced exams. The knowledge-comprehension levels of cognitive objectives set forth in the* Essentials of an Accredited Education Program for the Nuclear Medicine Technologist, *revised June 1976, have been translated into application-analysis-synthesis levels of cognitive objectives to be used in the clinical environment as a learning tool to guide students.

Nuclear medicine technology has for several years been recognized as a technology separate from related technologies of diagnostic radiology and clinical pathology. This year, the Nuclear Medicine Technology Certification Board, sponsored by nuclear medicine technologists, will give its first examination. Registry exams in nuclear medicine technology have been sponsored for several years by the American Society of Clinical Pathologists and the American Registry of Radiologic Technologists as special exams in these two branches of diagnostic medicine. These exams have followed the traditional pattern of norm-referencing, wherein the pass-fail mark is set one standard deviation to the left of the mean score. In normal distribution this means that 16% of the examinees will fail regardless of what their scores might be. Minimally acceptable requirements are not associated with the norm-referenced exam; the examinee's success in passing the exam is dependent upon the number of individuals taking the exam and how his score ranks with the group (*1*).

The nuclear medicine technologist of days past might have been qualified to take the registry exams as a result of on-the-job training, or he might have been a student in one of the schools set up under the guidelines of the *Essentials* as they were established by the AMA Council on Medical Education in 1969.

In June 1976, the revised *Essentials of an Accredited Educational Program for the Nuclear Medicine Technologist* was established by the AMA Council on Medical Education. (*2*). The most significant difference in the revision is that is has been adapted to a criterion-referenced exam based on learning by objectives. This means that the student is presented with a set of objectives for a unit of learning and when he has met the objectives, he is ready to move on to the next unit (*3*). Criterion referencing refers to evaluating the student on the basis of the criteria or tasks set forth in the objectives, with a pass-fail point or a minimum standard of acceptance having been set before the exam. Each student's exam score is independent of all other exam scores. Both the ASCP and ARRT registry exams are planning to evolve into criterion-referenced exams. Currently the NMTCB is developing task analysis, and identifying the skills and knowledge required to perform nuclear medicine procedures; these factors are prerequisites to establishing a criterion-referenced exam (*4*).

Criterion referencing and learning by objectives bring to the educational arena the concept of teaching by objectives. Our faculty has been using objectives in both the didactic and clinical teaching areas for the past year and we have found this instructional method to be very effective. The educational objectives presented in the *Essentials* have been expanded into behavioral objectives in terms of student behavior, so that the student knows exactly what he is expected to learn.

The objectives presented in the *Essentials* are lower level cognitive objectives (*5*), which are applicable to both didactic and clinical areas of the student's training. Using the *Essentials* as a guideline, we have developed objectives for each didactic course being taught in our program. In addition to the didactic objectives, we have recognized a need for higher level cognitive and affective objectives that relate directly to what the student is learning in the clinical environment.

The clinical objectives presented herein are pro-

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gressive: the student begins the first quarter with no clinical skills in nuclear medicine technology. Therefore, his beginning role is as observer, but he advances to a role of assistant as the quarter progresses. During the second quarter, the student's role should become more responsible in the performance of routine procedures. During the third quarter, as the student progresses in his self-confidence, skills, and knowledge, he is able to function without assistance, while under the observation of the clinical technologist, and perform routine procedures and daily chores. The fourth quarter in our program is more nearly an apprenticeship period, in which the student should be able to perform all duties of the department within the standards of acceptance of that department, yet under the supervision of a qualified technologist. See Tables 1 and 2 for an outline of the NMT-Certification Program at the Medical College of Georgia and an example of a typical student's schedule.

The objectives, as currently used in our program, are broad based in some areas because the students are rotated through five different clinical areas during the course of the year. There are variations in types of procedures, equipment capabilities, and performance standards among the five hospitals comprising our three major and two minor clinical affiliates. In order to make the objectives applicable to all students, regardless of their clinical rotations, non-specific objectives are supplemented with additional objectives for specific clinical learning. See Appendix for an example of specific objectives given the student during one of his rotations.

TABLE 1. Course Outline: Certificate Nuclear Medicine Technology

Course Title	Hours per week Lecture	Laboratory
Fall quarter (September through December)		
Physics of nuclear medicine (basic physics and instrumentation)	3	2
Electrical fundamentals	1	0.5
Introduction to NMT (patient care, ethics, etc.)	1	0
In vivo NMT	3	2
Clinical practice	0	20
Winter quarter (January through mid-March)		
Physics of nuclear medicine	4	2
Seminar (reading and conference)	1	0
In vivo NMT	3	2
Administration	3	0
Clinical practice	0	20
Spring quarter (mid-March through May)		
Physics of nuclear medicine (radiation safety and quality control)	2	2
Computer programming	2	0
Radiochemistry (in vitro NMT)	3	2
Radiobiology	2	0
Clinical Practice	0	20
Summer quarter (June through August)		
Clinical Practice	0	40

General Clinical Objectives

First Quarter. By the end of the first quarter of clinical practice, the student will be able to:

1. Assist the supervising technologist with routine studies being performed in the department; the degree of assistance the student will be allowed to provide will be determined by the technologist on the basis of the student's initiative and ability.
2. Assist department personnel with patient record filing and retrieval of patient data from the files.
3. Assist department personnel with transportation of patients to and from the department when the need arises.
4. Assist department personnel with nursing care required by the patient while in the department.
5. Load all types of film casettes used in the department.
6. Develop, process, label, and mount all types of film according to departmental procedures.
7. Describe the quality control procedures performed in the department.
8. Locate records of all quality control procedures performed in the department and state the time interval at which each procedure is performed.
9. Locate the emergency equipment and supplies kept in the department.
10. Recite the emergency code (phone number) of the hospital and department.
11. Recite personnel safety regulations observed by the department.
12. Locate radionuclide records kept by department personnel and explain the mechanism of record keeping.
13. Elute the generator and assay the eluate for impurities.
14. Calculate patient doses on the basis of half-life and activity.
15. Prepare patient doses, observing sterile technique, under supervision of the technologist.
16. Assist with radiopharmaceutical preparation, particularly technetium kits.
17. Assist with routine cleaning of patient areas, radiopharmaceutical preparation areas, labs, and so forth.
18. Assume the responsibility for maintaining cleanliness and neatness of the area in which he is working.
19. Assume responsibility for personal safety and hygiene.

20. Assess proper patient identification before a procedure is begun.
21. Assist the technologist to assure patient safety and comfort in all departmental areas.

Students should also be allowed to observe or assist (according to their experience level) with any infrequently performed procedures scheduled during their rotation in the department.

Second Quarter. By the end of the second quarter of clinical practice the student, in addition to the objectives set forth for the first quarter, will be able to:

1. Demonstrate competence in the performance of routine department chores, such as film processing, filing, record keeping, and general patient care.
2. Accurately prepare radiopharmaceuticals and patient doses.
3. Perform quality control checks on all radiopharmaceuticals, with the technologist's supervision and approval.
4. Assist with instrument quality control studies done during the student's clinical hours.
5. Assist with in vitro studies during rotations in wet labs.
6. Function as the "major" technologist in routine studies (brain, bone, liver, lung, thyroid, etc.) when feasible, while technologist assists.
7. Function as assistant technologist with nonroutine studies.
8. Perform intravenous injections of radiopharmaceuticals for certain types of studies on non-difficult patients, in conformance with hospital policy, under supervision of the physician responsible.
9. Recognize malfunctions in the equipment being used by the student and report such to the supervising technologist.
10. Relate positively to the patient in a professional manner to promote confidence and cooperation throughout the study.
11. Recognize mistakes he has made and take immediate steps to correct them, after reporting the error to the supervisor.

Third Quarter. In addition to the objectives set forth for the first and second quarters, the student, by the end of the third quarter, should be able to:

1. Perform routine procedures without assistance.
2. Function as "major" technologist during nonroutine studies with the supervising technologist functioning as the assistant.
3. Perform routine in vitro procedures in accordance with departmental capabilities.
4. Administer radiopharmaceuticals in departments where students are allowed by hospital policy, under supervision of the responsible technologist.
5. Continue to assist with a reasonable share of routine chores relating to the student's work area.
6. Assist with administrative processes such as replenishment of supplies, scheduling of patients, etc.
7. Perform all instrumentation quality control procedures in accordance with departmental policy.

Fourth Quarter. At the end of the fourth quarter, the student will also be able to:

1. Demonstrate proficiency in the performance of all imaging procedures done in the department during the fourth quarter rotation.
2. Demonstrate proficiency in the performance of routine assays.
3. Demonstrate competence in the performance of Schilling's Test, thyroid uptake, and routine in vitro procedures done in the department during the fourth quarter rotation.
4. Perform with the use of a procedure manual the following tests: nonroutine imaging procedures; blood volume determinations; ferrokinetic studies; GI absorption studies; blood and protein loss studies; red cell survival and sequestration studies; and iodine therapy and phosphorous therapy.
5. Perform nonroutine RIAs with the use of kits.
6. Perform radiopharmaceutical, radioassay, and instrument quality control tests and critique the results to determine the effectiveness of the procedure and the usability of the product, data, or instrument.
7. Critique film or other test results for quality and accuracy.
8. Discuss all administrative policies and procedures of the department in which the fourth quarter rotation takes place.
9. Maintain all department records, patient records, and the patient filing system.

Our objectives set forth for the four quarters of the certificate student's clinical practice, along with the following objectives, summarize the certificate nuclear medicine technologist's proficiency:

- Maintain equipment in good working condition through quality control checks, minor adjustments, and trouble shooting (to know when a technical repairman should be called in).
- Correlate the need for various additional information or related studies on the basis of preliminary test results or images, while the patient is still in the department.
- Assure the safety of the patient in the department

TABLE 2. Fall quarter schedule for certificate NMT students.*

Period	Time	Monday	Tuesday	Wednesday	Thursday	Friday
1	7:00					
2	8:00					
3	9:00			in vivo NMT lab		electrical fundamental lecture and lab
4	10:00			in vivo NMT lab		
5	11:00					physics lecture
6	12:00	in vivo NMT lecture	in vivo NMT lecture		in vivo NMT lecture	
7	1:00				physics lab	introductory lecture
8	2:00				physics lab	
9	3:00	physics lecture		physics lecture		

*Shaded areas indicate clinical practice.

through knowledge of radiation protection, basic nursing techniques, and a firm program of physical safety for the patient.

Evaluation

These objectives are evaluated by a four-point rating scale and by anecdotal records kept by the clinical instructors. Evaluations are made at mid-quarter and at the end of each quarter, before the student rotates to another clinical area. At mid-quarter, the clinical instructor meets individually with each student to discuss his progress, pinpoint areas of needed improvement, and point out areas of excellence. Another conference between the clinical instructor and student is held at the end of the quarter for final review and evaluation. Conferences are held between the clinical coordinator and the student to determine the student's self-evaluation of his progress and to discuss areas of clinical deficiency or areas in which the student may need to alter his rotation schedule to allow proper emphasis on his particular needs.

Conclusion

The use of these objectives in the clinical environment has enhanced the learning process for the student by making him aware of his responsibilities in the clinic and by giving him a general guideline for his specific clinical activities. For the clinical instructor, the objectives furnish a planned pattern of learning activities based on the student's rate of learning and ability to develop clinical skills.

Clinical evaluation is simplified since both the student and clinical instructor know exactly what is expected during a set period of time; thus they are better able to measure actual progress against expected progress.

References

1. Hammersberg S: Criterion-referenced examination—A new concept in testing. *Laboratory Med* 8: 39–40, 1977

2. AMA Council on Medical Education: Essentials of an accredited educational program for the nuclear medicine technologist. *Radio Tech* 48: 681–688, 1977

3. Stevens RD, Hendee WR, Cahney EL: Instructional objectives in radiologic technology. *Appl Radiol* 2: 29–31, 1973

4. Society of Nuclear Medicine: Task Force Meets, Explores New NMT Registry Exam, *J Nucl Med Tech* 4: 166–167, 1976

5. Gronlund NE: *Measurement and Evaluation in Teaching,* 2nd ed, New York, Macmillan, 1971, pp 528–531

Appendix: Specific Objectives for Radiopharmacy Practice—First Quarter

The student is expected to be in the department at 7:30 a.m. in order to have the radiopharmaceuticals ready for administration to patients at 8:00 a.m.

The student will assist with receipt and disposal of radioactive materials by verifying labels with packing slip when shipment arrives and recording type of radionuclide; activity (total); specific activity; lot number; and calibration date.

The student will assist with performing wipe tests on all packages received within the radiopharmacy.

The student will help to maintain disposal records of all radionuclides according to use or according to one of the following methods of disposal: depositing in decay bin until background levels are less than 0.1 mr/hr or removal by radiation safety officer for disposal by his department.

The student will assist with generator elution and quality control of the eluate. The student should be able by the end of the practice period to:

1. Check calibration of dose calibrator on a daily basis using a 1-mCi Cs-137 standard.
2. Determine the total activity and activity per ml of eluant.
3. Assay the eluant for molybdenum and aluminum breakthrough.
4. Observe and assist with radiopharmaceutical kit preparations.
5. Determine tagging efficiency of kit products through chromatographic quality control procedures.
6. Maintain radiopharmacy records of kit usage, quality control, and administration of all radiopharmaceutical products.

The student is expected to keep his area clean and free of any unshielded radioactive sources; he must follow all radiation safety and sterility precautions while working in the radiopharmacy. The student will be able to perform radiation survey procedures such as wipe tests in his area.